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Case Report

Penetrating craniocerebral injury caused by a rubber bullet questions the relative harmlessness of these weapons☆,☆☆

Abstract

Rubber bullets are less lethal weapons, which are increasingly used to incapacitate dangerous individuals. Despite their low penetrating power, significant morbidity has been described. Here, we report the first case of adult brain trauma consecutive to a rubber bullet.

Self-defense guns are designed to provide high stopping power without inducing severe injuries. Since their first use by the British forces in Northern Ireland in 1970, such weapons have been designed to cause fewer and less harmful effects. Rubber bullets are now intended to inflict superficial painful injuries, thereby deterring demonstrators from continuing further hostile activities, while at the same time avoiding serious injuries and deaths that arise with conventional firearms. Previous reports of serious injuries and even deaths, caused by hard rubber bullets, have prompted the development of soft rubber bullets [1]. In the present work, we report a case demonstrating that "less-lethal weapons" may yet induce direct severe penetrating craniocerebral injuries, thus putting the relative low risk generally associated with such weapons into perspective.

A 21-year-old man presented himself in a local emergency department with a penetrating injury in the pterional area with issue of brain through the skin opening. Physical examination demonstrated a hemodynamically stable injured patient, with no respiratory distress. His clinical examination was otherwise normal. A cranial computed tomographic (CT) scan showed a 20-mm diameter rubber ball (Fig. 1A and B) in the right frontal lobe, associated with several in-driven bone fragments in the left frontal lobe, pneumocephalus, and subdural hemorrhage. He was addressed to our neurosurgical department where he underwent a surgery for soft tissue repair and removal of the bullet (Fig. 2) and aggressive management of secondary intracranial hypertension. After controlling intracranial pressure, a second surgery was performed to remove a depressed skull fracture of the orbital roof compressing the left eyeball and responsible of a left eye exophtalmia associated with major chemosis. Three months after admission, the patient does not present any sensitivo-motor deficit but lost vision in his left eye, and he demonstrates neuropsychologic disorders requiring rehabilitation.

Nonlethal weapons are designed to incapacitate individuals rather than to induce fatal injuries. There are many classes of "nonlethal weapons" including conducted electrical weapons (commonly referred to as a TASER), chemical irritants (pepper spray), and impact munitions. Impact munitions include "bean bag rounds" and rubber bullets. Notably, rubber bullets deliver a blunt impact without causing penetrating injuries. However, with the increasing use of rubber bullet shots, cases of penetrating chest injury [2], severe eye and facial trauma [3-5], or pediatric head trauma [6] due to low-velocity rubber bullets have been reported. To our knowledge, we report in the present work the first case of adult penetrating brain trauma consecutive to a rubber bullet.

The velocity of the "bullet" upon impact is the major factor determining the severity of injuries [7]. Furthermore, an important factor determining the velocity upon impact is the projectile's ballistic coefficient, which represents its ability to overcome air resistance. Rubber bullets have a low ballistic coefficient resulting in their unstable flight. Thus, rubber bullets are intended to transfer their low kinetic energy to the victim at below an estimated distance of 40 meters [7]. Furthermore, rubber bullets are blunt nosed, with a low muzzle velocity of approximately 70 m/s.

When a projectile strikes a person, its kinetic energy upon impact is defined by its mass and its velocity ($1/2 \times \text{mass} \times \text{velocity}^2$) [8]. Given their low velocity, low mass (mean weight, 28 g), and small ballistic coefficient, the only factors that affect penetration and severity of injuries by rubber bullets remain the elastic limit and viscosity of the body area that is injured [7]. In areas with a low elastic limit (eg, the thin bones of the face), severe penetrating injuries are frequently observed. To date, no penetration of rubber bullet into an adult brain had been described. Per contra bones of the face, pterional area is thick (5-9 mm), hard and partly covered by the temporal muscle. This anatomical association ensures the curve, the rigidity, and the protection of the temporal fossa. For our patient, bone damages and the penetration of a rubber bullet through pterional area indicate that the blow was probably fired at point-blank range.

In 3 of 10 people studied by Hiss et al [9], rubber bullets caused blunt injuries such as lethal brain damages ($n = 2$) or cervical spinal injury ($n = 1$) without penetrating internal structures. Similarly, 34% (52) of 152 patients included by Mahajna et al [5] had head injuries caused by rubber bullets, including more severe head injuries, depressed fractures of the skull, or fractures of the base of the skull. Subarachnoid hemorrhage and epidural and subdural hematoma were noted with extended periods of unconsciousness and loss of memory. Nevertheless, no penetration into the brain was again observed, and no surgery was needed. All patients responded to conservative treatment.

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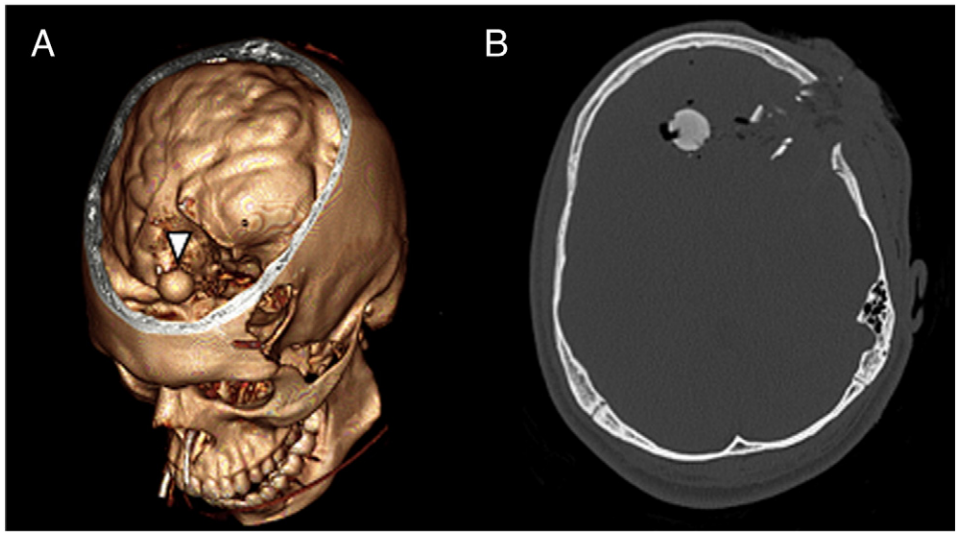

Fig. 1. A, Three-dimensional reconstruction of the CT scan on admission; white arrow head, rubber bullet. B, Bone CT scan on admission, axial view.

Like in our case where a first brain CT scan was performed, penetrating injuries from a rubber bullet should be imaged by CT scan with contrast to allow evaluation of the course and the final localization of the bullet and identification of internal injuries caused by the bullet, all the more if the outlet hole has not been identified.

Internal injuries induced by rubber bullets could largely be ascribed to direct compression or a crushing-type mechanism of tissues by the blunt tip of the bullet or to the shockwave generated by the impact, which creates lacerations and fractures distant from the area of impact.

Because the rubber bullet is a nonsterile and low-velocity missile, local infection may occur. Moreover, the rubber shell may gradually disintegrate within the brain and release a toxic material [10]. Therefore, we chose to promptly remove the rubber bullet by surgery. This first case of brain trauma confirms that nonlethal weapons can induce extremely severe brain trauma. We, therefore, recommend that such patients should be investigated rapidly and treated following the same guidelines as other patients who might have suffered high energy blunt trauma [11].

These guns are, nevertheless, extremely harmful when handled by average citizens [12]. Less lethal weapons cannot be considered solely as defense weapons.

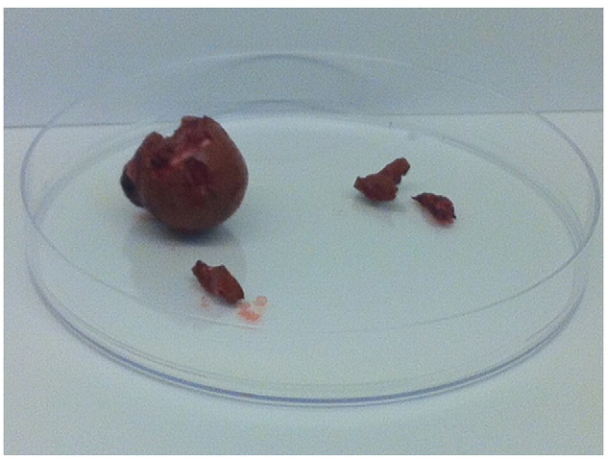

Fig. 2. Rubber bullet after surgical removal.

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